THE WEATHER AND CIRCULATION OF JANUARY 1960

Another January With Atlantic Blocking

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1. INTRODUCTION

In all but one year since 1954, mean 700-mb. maps for January have contained centers of large positive height anomaly near Davis Strait with negative anomalies to the south. This pattern of vigorous blocking over the western Atlantic Ocean was again observed during January 1960 (fig. 1). The mean for this January particularly resembled that for January 1955 [1]. Furthermore, both maps evolved in the same manner over the contiguous United States, with a trough in the West and a ridge in the East in the first half-month, a ridge in the West and a trough in the East in the second (fig. 2, and fig. 3 of [1]).

Because of its transitional circulation, January 1960 established few new records of extreme weather for the month. However, new totals for excessive precipitation amounts were recorded in Iowa, and for deficient amounts in Washington and extreme southern Florida. Previous marks of high and low temperature for the month were unchallenged, but the warm maritime regime which had characterized December 1959 [2] yielded to a January circulation favoring colder temperatures.

2. OTHER ASPECTS OF THE GENERAL CIRCULATION

Figure 3A illustrates the extensive increase of height anomalies over northern latitudes from December to January, especially in centers near Iceland, the Arctic Ocean, and the Gulf of Alaska. With the extensive blocking at high latitudes, negative changes appeared at middle latitudes. The resulting channel of negative anomalies was remarkably continuous (fig. 1), being interrupted at only one place by a weak positive tongue south of Alaska.

Figure 3B illustrates mean 700-mb. height changes from the first to the second half of January. The broad zone of height rises from the Labrador Sea westward and the flanking areas of falls accent the progress of blocking within the month. A distinct westward shift is evidenced by the intensity and the remarkable extent of the negative change in the Pacific.

Blocking was prevalent in Canada during December 1959, and it had spread westward to the Gulf of Alaska and the Siberian Peninsula near the end of that month. By January 10 the Siberian segment had retrograded about the pole, and a positive center had become well established in the Greenland Sea (from 5-day means, not shown). The center continued to grow and move westward, reaching maximum 5-day mean intensity over Baffin Island around January 18. Thereafter, a surge spread rapidly to western Canada and across the Polar Basin to northern Greenland the following week. While considerable similarity existed in the initial state and subsequent behavior of blocking in December as compared to January, there was one important difference. A large portion of the December surge joined and amplified the subtropical ridge in the Gulf of Alaska. That strong mean ridge and the trough downstream from it were prominent features of the early January circulation (fig. 2A) and strongly influenced the weather of the United States during the first half-month.

Accompanying the increasing positive anomalies at high latitudes was a southward depression of the mean westerlies. Solid arrows tracing the observed axes of maximum westerlies in figure 4 are south of the normal axes (dashed) over much of the hemisphere. The southward shift was most pronounced over the extreme eastern Pacific, the contiguous United States, and the Atlantic (where the strongest blocking prevailed). Normal and observed axes nearly coincided over most of the Pacific, and wind speeds there generally exceeded normal (fig. 4B). Southward from 40° N. in the Atlantic, positive departures were greater, exceeding 7 m.p.s. in a rather large area enclosed by the 20 m.p.s. isotach south of Newfoundland. On the other hand, negative departures of as much as 12 m.p.s. occurred just north of Newfoundland.

The mean wind speed profile of figure 5 helps to summarize the effects of blocking through a segment of the hemisphere from 175° E. eastward to 5° W. Depression of the westerlies is shown in this figure as a southward displacement of the wind field at all latitudes south of 65° N. The mean westerly deficit north of 41° N. and the compensating excess to the south are typical of widespread blocking at high latitudes [3].

The strength of the temperate westerlies diminished as height anomalies increased north of 55° N. The curve of figure 6 depicts the recovery of the 5-day mean zonal index from a late December decline to a maximum in early January. This was followed by a sharp drop during

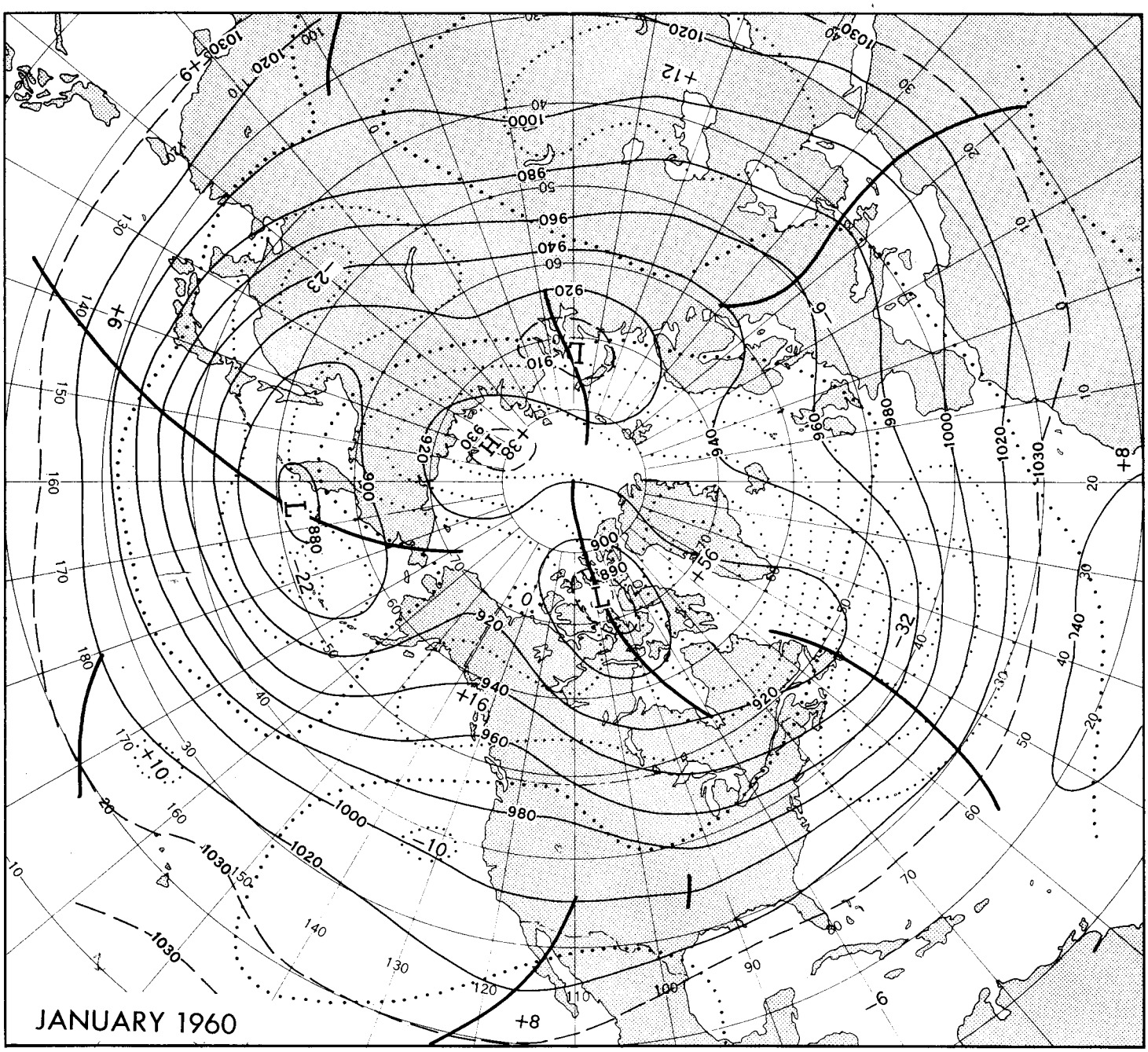

FIGURE 1.—Mean 700-mb. contours (solid) and height departures from normal (dotted), both in tens of feet, for January 1960. Troughs are indicated by heavy solid lines. Positive anomalies predominated at polar latitudes, and the surrounding channel of negative anomalies was nearly continuous around the hemisphere.

the middle of January to 5.9 m.p.s., the lowest value observed since August 1959. Except for a brief period, the index remained below normal, and the monthly mean value diminished from 1.9 m.p.s. above normal in December to 2.4 m.p.s. below in January.

Subtropical westerlies increased correspondingly from 2.8 m.p.s. below normal to 2.2 m.p.s. above. Temperature anomalies in the contiguous United States in general corresponded to the 5-day mean index, by cooling as the index fell and warming as it rose.

3. TEMPERATURES

Woffinden [2] described the abrupt change to a warm December from a cold fall season. Cooling began in late December, however, and was predominant thereafter with short-period variations over much of the nation until late January. Temperature persistence between the two months was 72 percent (within change limits of one class [1]), which conformed closely to the average 71 percent for

[1] Temperature classes are much above and much below normal (12½ percent occurrence each) and above, near normal, and below (25 percent occurrence each).

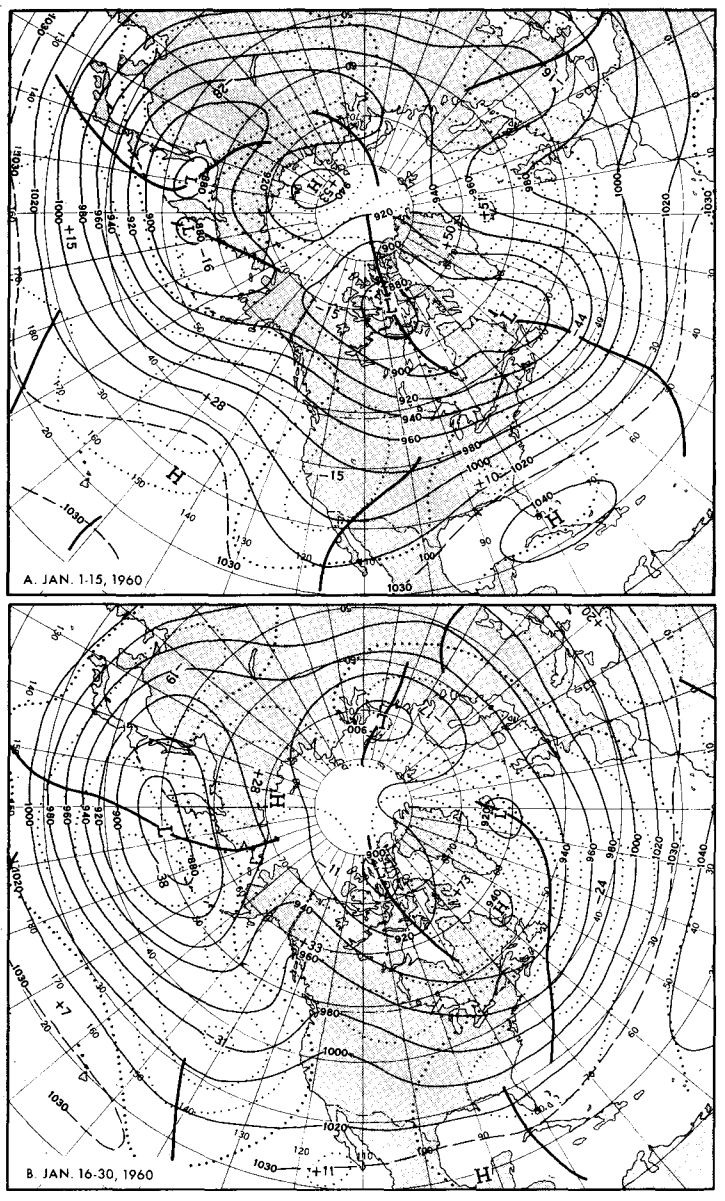

FIGURE 2.—Mean 700-mb. contours (solid) and height departures from normal (dotted), both in tens of feet, for (A) January 1–15, and (B) January 16–30, 1960. Blocking was centered over Greenland and Iceland for the first half-month, and large-amplitude waves were observed over the eastern Pacific and the contiguous United States. During the second half blocking was strongest from Davis Strait to the Yukon, and the trough-ridge structure over the United States reversed phase.

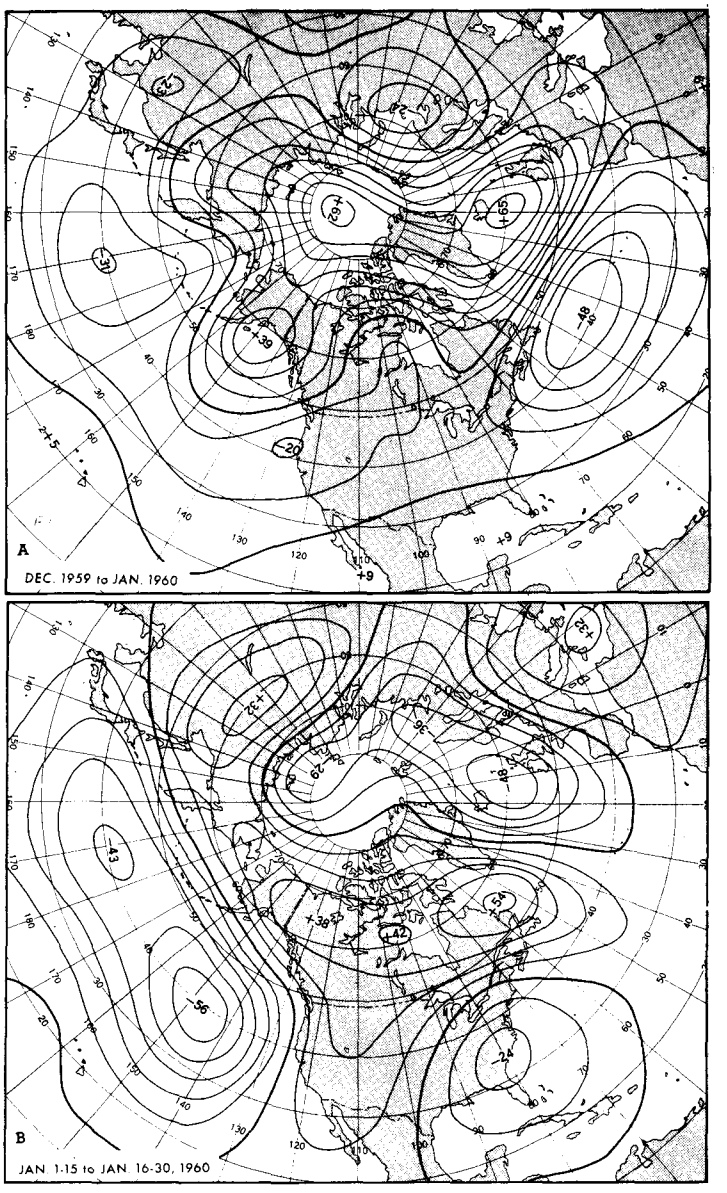

FIGURE 3.—(A) Difference in tens of feet between mean monthly 700-mb. height departures from normal of December 1959 and January 1960. (B) Change in half-month mean heights from January 1–15 to January 16–30, 1960 (in tens of feet). Both charts have large rises at high latitudes and falls at middle latitudes, indicating the progressive increase of blocking from month to month and through January.

1942–54 determined by Namias [4]. However, 73 of 100 well-distributed stations cooled by one class or more, and only 21 averaged above normal in January.

This cool pattern (fig. 7A) agreed well with the low zonal index and depressed westerlies of the mean circulation. Below-normal temperatures across the southern portion of the United States were associated with a channel of negative height anomaly (fig. 1). Combined effects of the abnormally strong ridge over western British Columbia and the mean trough in the Southwest were related to below normal temperatures from the Great Basin northward. Some of the cold air from western Canada pushed southward east of the Continental Divide to help produce cold anomalies in the Central Plains.

Above-normal temperatures in the Northeast were related to the easterly anomalous flow (fig. 1) from a

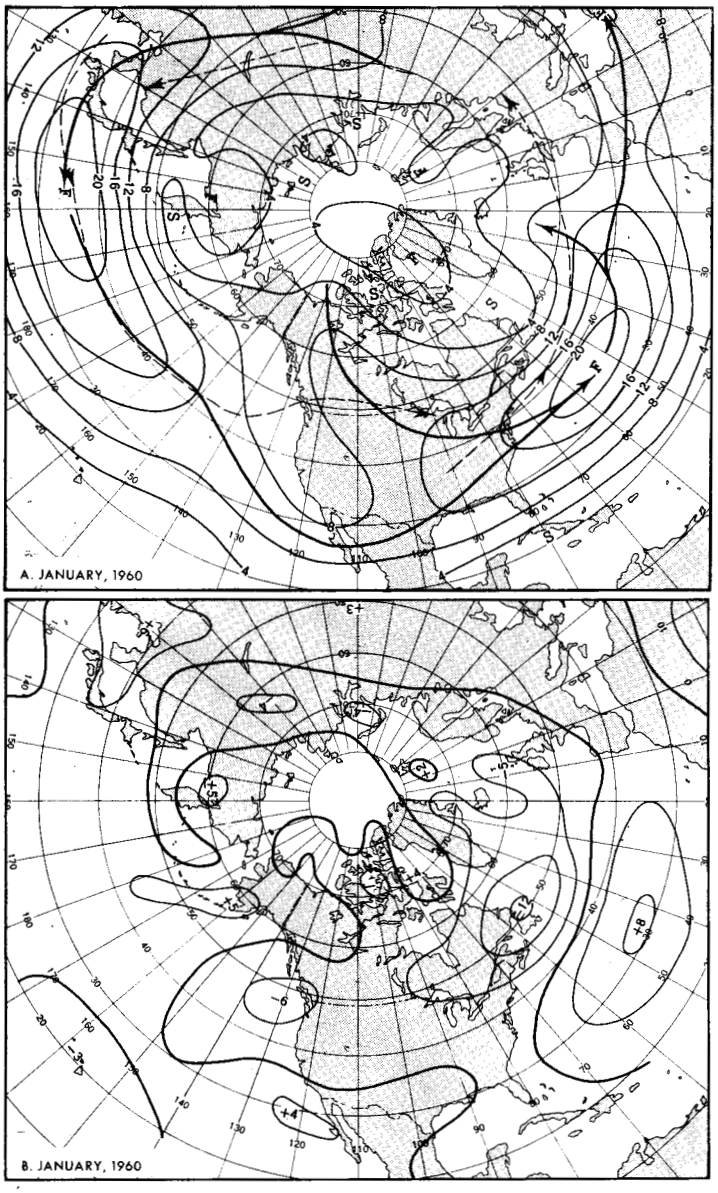

FIGURE 4.—(A) Mean isotachs in meters per second of 700-mb. wind speed during January 1960 and (B) departure from normal wind speed. Solid arrows in (A) indicate observed axes of maximum wind speed, and dashed arrows the normal. This month's axes were generally south of normal except in the Pacific.

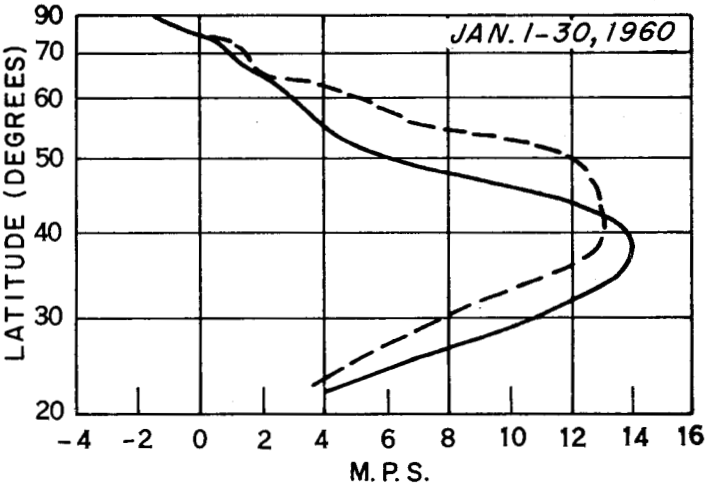

FIGURE 5.—Mean 700-mb. zonal wind speed profiles in the Western Hemisphere for January 1960 (solid) and January normal (dashed). The displacement of the observed profile southward from normal south of 65° N. was associated with blocking.

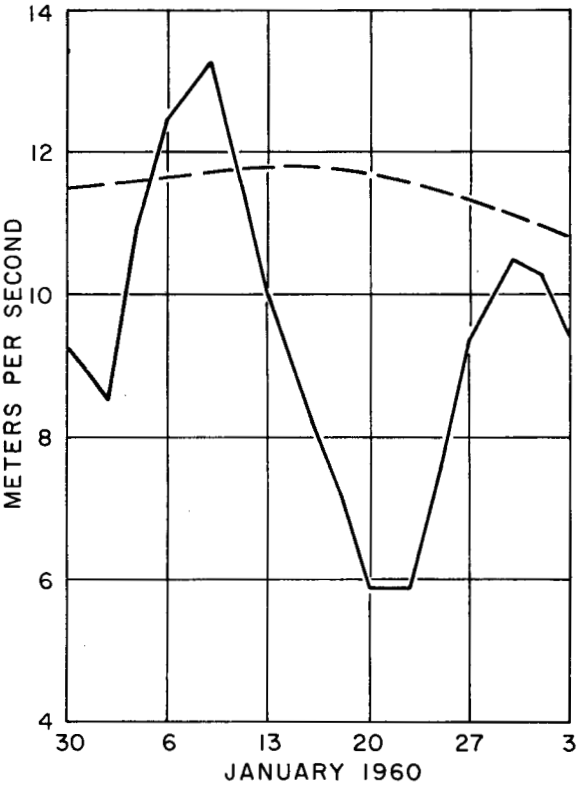

FIGURE 6.—Time variation of zonal index in meters per second for the Western Hemisphere in the latitude belt 35° to 55° N. A complete oscillation of the index occurred in January 1960, reflecting the transitional nature of the circulation. The mean index for the month was 2.4 m.p.s. below normal (dashed curve).

maritime, rather than a continental, source region. Temperatures along the west coast of the contiguous United States averaged a little above normal due to strong warming in southerly flow during the second half of the month. In southern California, however, the warming was not sufficient to compensate for cool weather during the first half of the month. A near-normal average at San Diego was the first monthly mean temperature since March 1958 which was not much above normal. The monthly average was close to the normal at Los Angeles and below at Santa Maria, so that the

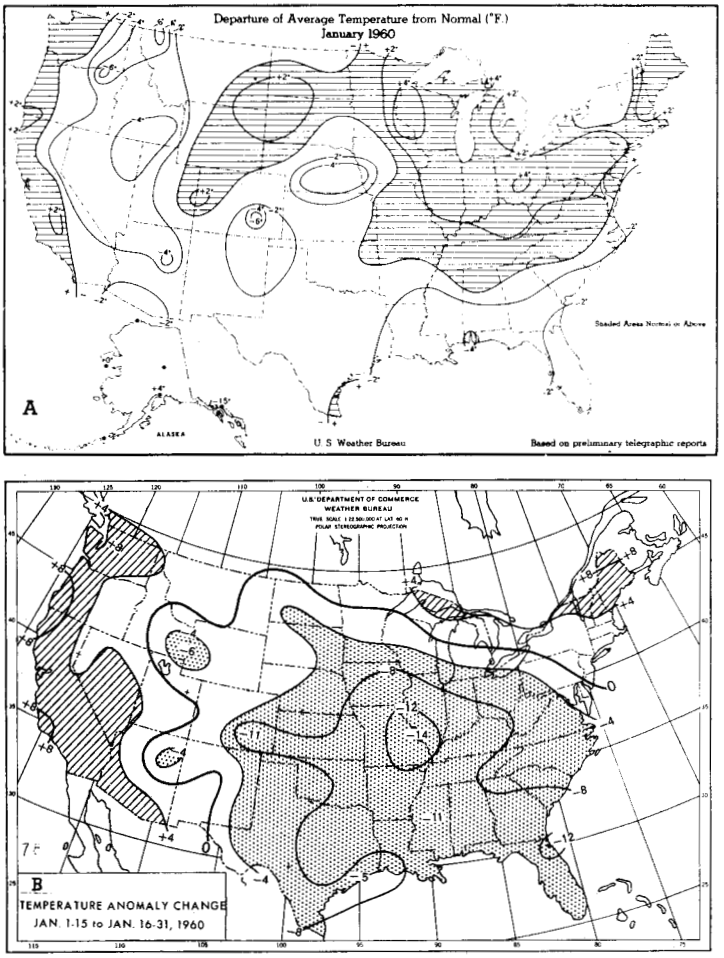

FIGURE 7.—(A) Departure from normal of average temperature (° F.) for January 1960. Hatching indicates positive departures (from [6]). (B) Temperature anomaly change (° F.) from January 1–15 to January 16–30, 1960. Hatching indicates positive change of 4° F. or more; stippling, negative change of the same magnitude. A circulation reversal encouraged southward penetration of cold air east of the Continental Divide during the second half-month.

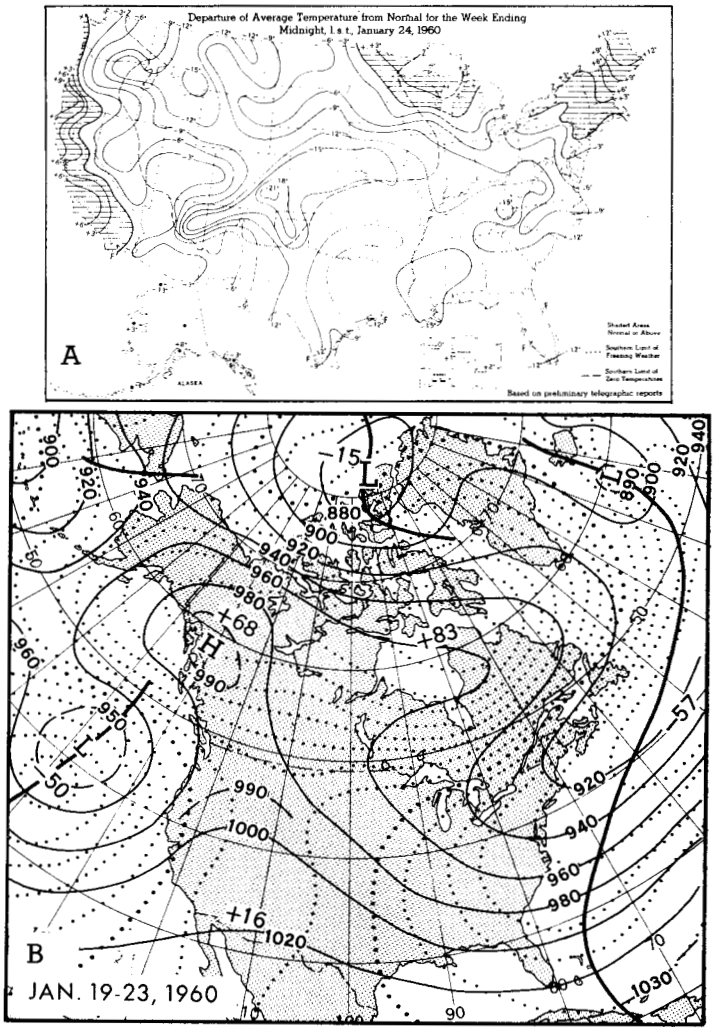

FIGURE 8.—(A) Departure from normal of average temperature (° F.) for the week ending January 24, 1960 (from [6]). Cold air flooded the country as a mean trough advanced from western United States and a blocking surge retrograded rapidly across Canada. (B) 5-day mean 700-mb. heights (solid) and departures from normal (dotted), both in tens of feet, for January 19–23, 1960, representing the mean circulation during the week described in (A).

long period of extremely warm temperatures along the southern California coast was at least temporarily interrupted [2].

In view of the circulation changes within the month, it is not surprising that the anomalies just described were rather weak and their configuration was ill-defined. Some additional information about the temperatures can be obtained by considering them in relation to shorter-period means of the circulation.

Temperatures were coldest in the western trough and warmest in the eastern ridge during the first half-month. Around midmonth the mean trough moved rapidly eastward, the zonal index continued to drop, and cold air flooded most of the country. Figure 7B outlines the change which resulted. The area of greatest cooling between half-months occurred in eastern Missouri and southwestern Illinois. There the mean 700-mb. flow (fig. 2) shifted to northwesterly and became more cyclonic, while the anomalous flow reversed from a southerly to a northerly direction.

Cold was most intense and widespread during the week ending January 24 (fig. 8A). At this point the mean trough was off the east coast (fig. 8B), blocking over Canada was at a maximum, and the zonal index reached its minimum for the month. High sea level pressure attending the cold air effectively inhibited the march of surface cyclones across the contiguous United States, and

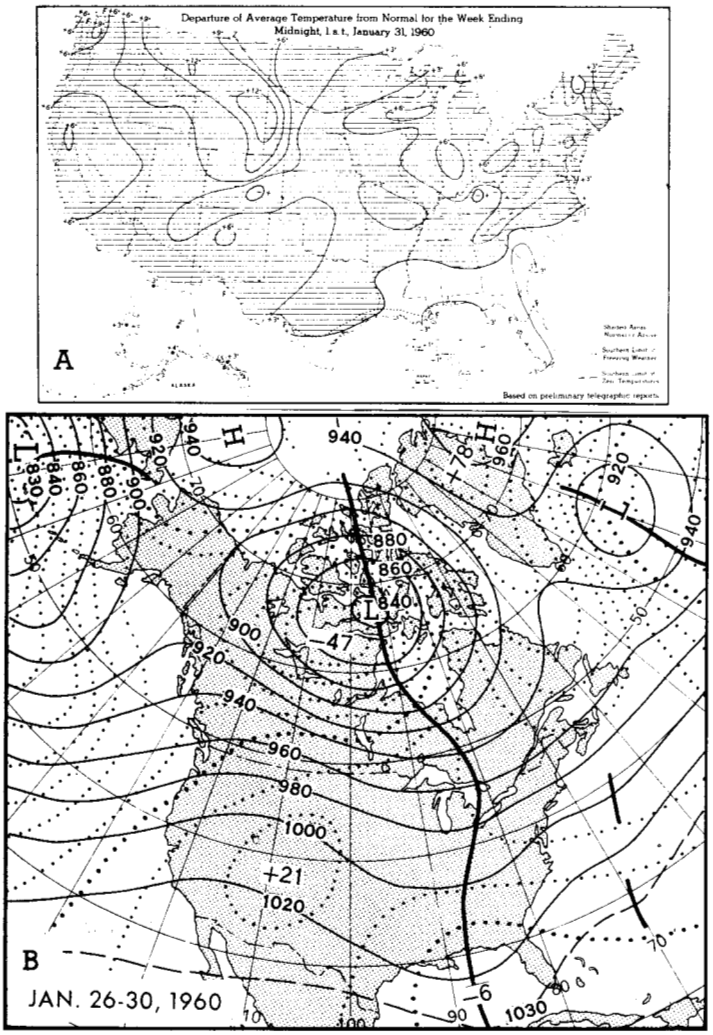

FIGURE 9.—(A) Departure from normal of average temperature (° F.) for the week ending January 31, 1960 (from [6]). Rapid warming followed the cold outbreak of the previous week (fig. 8). (B) The 5-day mean 700-mb. height (solid) and height anomaly (dotted), both in tens of feet for January 26–30, 1960, show the rapidly altered circulation which accompanied the warming.

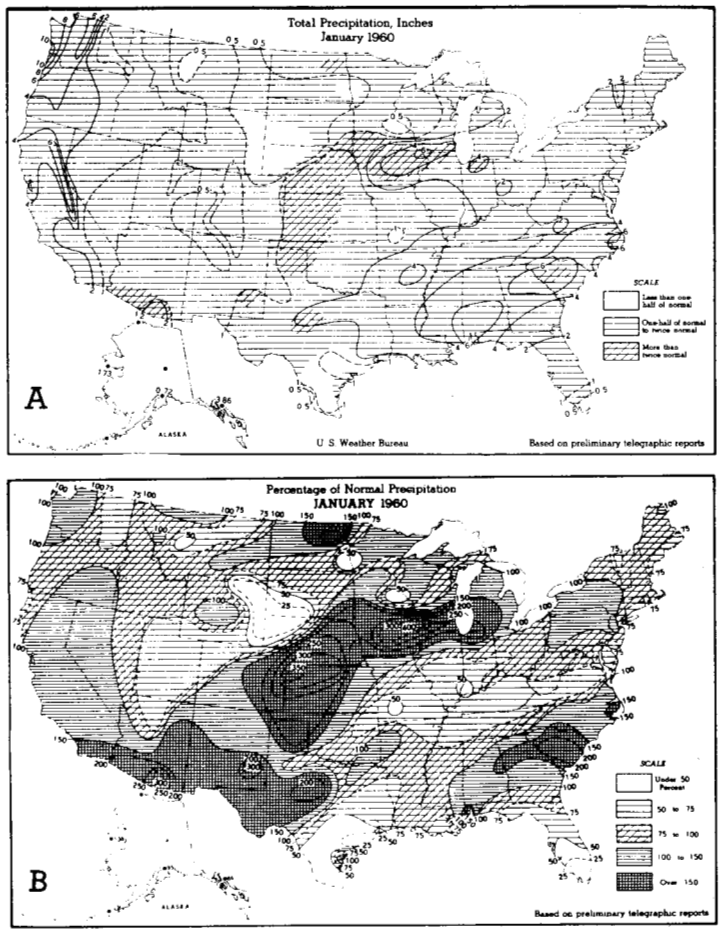

FIGURE 10.—(A) Total precipitation in inches for January 1960 (from [6]). Note the small size of unhatched areas representing less than half of normal. These areas are enclosed by lines labeled 50 on (B), the percentage of normal precipitation for January 1960 (from [6]). Outstanding feature of precipitation pattern is the streak of above normal from the Southwest to Michigan.

none was reported west of the Mississippi River from the 17th to the 27th (see Chart X of [5]).

Figure 9 shows the remarkable warming in the week that followed. Anomaly patterns this warm are typically attended by fast westerlies of small amplitude over the contiguous United States and below normal 700-mb. heights over Alaska and northwestern Canada. Such a circulation was quickly accomplished in this instance by the southward migration of a deepening polar vortex as blocking retrograded from Canada. A general increase of the westerlies occurred over the Western Hemisphere (see the index curve of fig. 6), and a 5-day mean trough was eliminated in the eastern Pacific as mean wavelengths increased.

4. PRECIPITATION

Low index mean circulations have been empirically described as "cold and wet," and this January conformed to that description. It was not only colder than normal, as indicated in the previous section, but also wetter than normal. Of the usual 100 well-distributed stations, only 15 reported precipitation totals in the light class, while 51 had moderate precipitation, and 34 had heavy. Since each class should normally occur one-third of the time, the occurrence of light had less than half its usual frequency.

Most of the precipitation pattern agreed well with features of the mean monthly circulation. A band of substantial (and above normal) amounts reaching from southern Arizona to Iowa (fig. 10) can be attributed to cyclonic activity along and east of the mean trough shown

in figure 1. Des Moines and Dubuque, Iowa, reported record totals for the month, most of which accumulated as three storms traversed a path from the Texas Panhandle to Lake Erie during the period from January 11 to 18. At Dubuque the 24-hour total of 3.75 inches on the 11th and 12th exceeded the previous wettest January total of 3.45 inches measured in both 1861 and 1869. The band of above normal amounts from the central Gulf Coast to North Carolina and another from North Dakota to Pennsylvania were aligned along the separate axes of maximum westerlies in figure 4.

Dryness from central Montana to western Nebraska occurred in the absence of a moisture source in the northwesterly flow ahead of the mean ridge of figure 1. Stampede Pass, Wash., reported the driest January on record, due in part to a mean deficit in the westerly winds which normally help to produce orographic precipitation. In Florida, West Palm Beach and Key West reported their driest Januarys on record. This was attributable in part to the presence of a northerly component in the 700-mb. mean anomaly flow for the month.

Most of the Nation's precipitation came in the first half-month when adequate moisture was supplied by southwesterly flow ahead of the western mean trough (fig. 2A). The abrupt change in circulation regime at midmonth brought precipitation to an equally abrupt halt over most of the country. An exception appeared in the Pacific Northwest, where precipitation increased as the mean flow backed from a northwesterly to a southwesterly direction. Additional precipitation occurred in the Southeast during the final week when a mean trough there retrograded sharply in response to the loss of a mean trough in the eastern Pacific (fig. 9B).

5. ALASKA AND HAWAII

Temperatures in southern and central Alaska were above normal because of a southerly component in the flow behind a mean ridge (fig. 1). The flow diminished northward, however, and northern coastal temperatures, already cold in December, remained so in January.

Alaskan precipitation was not far from normal for the month except for an excess over normal of 8.89 inches at Annette. This was the second wettest January on record at Annette and the 18th consecutive month with excessive amounts.

On windward Hawaii, Hilo reported 11.82 inches more rainfall than normal, but Honolulu, a leeward station, reported 4.17 inches less than normal. Lihue, with less pronounced orographic influences, reported a deficit of 5.26 inches. These precipitation totals were in general agreement with the mean circulation, which was slightly anticyclonic and exhibited a weak northerly component in the 700-mb. height anomaly field (fig. 1).

REFERENCES

1. W. H. Klein, "The Weather and Circulation of January 1955—A Month with a Mean Wave of Record Length," *Monthly Weather Review*, vol. 83, No. 1, Jan. 1955, pp. 14–22.
2. C. M. Woffinden, "The Weather and Circulation of December 1959—An Abrupt Change from a Cold Fall Season," *Monthly Weather Review*, vol. 87, No. 12, Dec. 1959, pp. 453–458.
3. J. Namias, "The Index Cycle and Its Role in the General Circulation," *Journal of Meteorology*, vol. 7, No. 2, Apr. 1950, pp. 130–139.
4. J. Namias, "The Annual Course of Month-to-Month Persistence in Climatic Anomalies," *Bulletin of the American Meteorological Society*, vol. 33, No. 7, Sept. 1952, pp. 279–285, and an unpublished extension through 1954.
5. U.S. Weather Bureau, *Climatological Data-National Summary*, vol. 11, No. 1, Jan. 1960.
6. U.S. Weather Bureau, *Weekly Weather and Crop Bulletin, National Summary*, vol. XLVII, No. 4, Jan. 24, 1960; No. 5, Feb. 1, 1960; and No. 6, Feb. 8, 1960.

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